DOCUMENT RESUME

ED 092 588 TM 003 700

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TITLE Task Analysis - Its Relation to Content Analysis.
PUB DATE 74
NOTE 17p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, Illinois, April, 1974)

EDRS PRICE MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS Classification; *Content Analysis; *Instructional Design; *Learning Processes; Mediation Theory; Stimulation; *Task Analysis; *Task Performance
IDENTIFIERS *Learning Outcomes

ABSTRACT

Task analysis is a procedure having the purpose of identifying different kinds of performances which are outcomes of learning, in order to make possible the specification of optimal instructional conditions for each kind of outcome. Task analysis may be related to content analysis in two different ways: (1) it may be used to identify the probably intended outcomes of existing content; and (2) it may be employed to design effective instruction, and thus to determine instructional content. When used for the latter purpose, the distinction is important between content which has a purely mathemagenic function, and content which is itself to be learned. When the intended outcome is an intellectual skill, verbal propositions provide cues for retrieval and other learning processes. In contrast, when the intended outcome is information, verbal statements must be learned as propositions, so that they can later be recalled and stated by the learner. (Author/RC)

ED 092588

TM 003 700

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Task Analysis - Its Relation to Content Analysis

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(Presentation to Symposium "Content Analysis for Instructional Design," Annual Meeting, AERA, Chicago, Illinois, April 18, 1974)

In 1964, I wrote about task analysis in relation to the design of instruction, and this writing was published in a book about programmed instruction a year later (Gagné, 1965). In that article, I traced several roots of the concept of task analysis, and emphasized particularly the contributions made by Robert Miller (1953a, 1953b) and others in connection with research on military training.

The date of this article, and also of its references, serve to remind us that the general problem of how to analyze the learnable components of human performance had been even at that time occupying the attention of some investigators for quite a number of years. As I look back now at the 1965 article, I see two things. One is that some additional clarification has been added in these intervening nine or ten years to the topic of task analysis. And another is that there are still some perplexing problems to be solved. Perhaps the fact that several participants in this symposium wish to bring their individual thoughts together means that some of the uncertainties surrounding this subject will be reduced.

The Purposes of Task Analysis

Why was "task analysis" proposed in the first place? What proble

theoretical or practical, was it designed to solve? As a beginning to my discussion, let me try first to answer these questions.

The question to which "task analysis" was proposed as a partial answer was this: Here are a number of tasks that human beings are expected to do. In most instances, they can become competent in performing these tasks by undergoing training, in other words, by "learning how." How can instruction be designed optimally so that people can learn how?

The general answer to this question given by the phrase "task analysis" was as follows. The tasks that people are expected to do must b analyzed into trainable components. First, each task must be broken down into behavior capabilities that are not themselves the task, but are contributors to the performance of the task. Second, these contributors must be further classified, if possible, into types that serve to identify different optimal conditions for their learning (and thus for the instruction that supports learning). Without such analysis and categorization, all one can say about optimal instruction is to apply general rules such as "motivate the learner," "use the principle of contiguity," and "arrange the contingencies of reinforcement." The unquestioned validity of these principles is not enough. With task analysis, one can begin to deal direc with the planning of instruction for different kinds of learning outcomes.

Task analysis, then, was conceived as a technique which could be brought to bear upon the problem of how to get from known human tasks to designed optimal conditions of instruction which would yield competence in those tasks. Of course, there are some tasks for normal human adults which need no instruction--such as "closes the door," or "makes a check mark," or "counts the number of people in a room." There are still other

which require a minimum of instruction, and which therefore need no instructional design, such as "to energize the starter, turn key to right," or "to turn on the lights, push the switch upwards." But in many other instances, people cannot perform the tasks competently without a measurable period of learning, often accompanied by instruction. Task analysis was proposed as a method of identifying and classifying the behavioral contributors to task competence, for which differential instructional design was possible and desirable.

Some Distinctions

I should like to review some of the distinctions that are involved in this definition of task analysis, since they may be seen to be important in later developments of the technique.

1. Job-tasks and learning tasks. First, a distinction was made between the task as a part of a job, and a learning task which might result from analyzing the learning requirements for that job-task. The task as part of a job is represented by such descriptions as "Traces a wiring diagram to find defective resistors." A learning task contributing to this task might be "Identifies resistor symbols in wiring diagrams." Obviously "task" has different meanings in these two contexts. The distinction was made by Miller (1956) on a number of occasions; he referred to the one as "job-task analysis" and the other as "training-task analysis."

Such a distinction may seem obvious. But apparently it is not. My observation has been that some planners of training do not employ this distinction even today. Furthermore, the distinction has its counterpart in public education. Let me give two examples. An objective for reading: "Correctly interprets the directions on medicine bottles." What is that?

It is something comparable to a job-task. That means that it must be analyzed--by a "learning-task analysis"--before one can begin to specify how instruction can best be defined. The contributors to the task must be identified and classified (or as we now sometimes say, the "enabling objectives"). Consider another example from English: "Composes a descriptive essay on an assigned event." This too is pretty close to being a job task. Again, a learning-task analysis must be applied to it, before we reach the categories which are useful in the design of instruction. I'm not sure anyone has done this, but that simply emphasizes the continuing importance of the problem involved in this distinction.

2. Categories of what is to be learned. A second set of distinctions in task analysis is the varieties of learning outcomes themselves; that is, the classes of learning objectives. These distinctions are an inherent part of the learning-task analysis, since it is these categories into which each job-task must be analyzed. I shall not repeat here the exact categories which occur in the 1965 chapter (Gagné, 1965), but simply point out that they included such classes of outcome as multiple discriminations, chains, concepts, principles, and strategies. These same classes of learning outcome were reflected also in the first edition of The Conditions of Learning, also appearing in 1965. Some refinements and renaming of these categories occured in the second edition (Gagné, 1970), but I need not describe these in detail for present purposes.

The main point is, task analysis had the specific purpose of identifying and classifying the performances that are the outcomes of learning. Without such classifying, there would have been no point to the technique. One can, of course, conceive of breaking down any complex performance into

finer units. Thus, one can "break down" the procedure involved in tuning a television set into such units as "(1) turn set on; (2) locate channel number; (3) turn channel selector" and so on. But such a breakdown, whil it may have its uses, is not a learning-task analysis, and obviously does not conform to the major aim of such analysis. The purpose of task analysis was and is to identify a number of different classes of learning outcome--performances which require different learning conditions for the attainment. This contrasts with a description of steps in a procedural sequence.

3. Stimulation, mediation, performance. The third set of distinc tions forming a part of the technique of task analysis may be the most important of all. At least this set seems most highly cogent to the issu of this symposium. Task analysis is a procedure which recognizes that an external observer (or investigator) can directly observe and describe the stimulus situation for learning, on the one hand, and the human performan which is the outcome of learning on the other. The middle part of this triple set, the mediation, is what the learning investigator must infer o postulate as part of his theory. This is the "information-processing" pa of learning. Task analysis, however, is not a theory, nor is it based up any conceptualizing that deserves to be called a theory. It is true that there is some theory in my writings (Gagné, 1970), but one may think of that as derived from task analysis, rather than being part of it. (I am not speaking against theory at this point, but merely wishing to argue tha theory is not an inherent part of the technique of task analysis).

The main point to be made is that the task anlaysis technique proceeds backwards from the human performance, through information-proces mechanisms, to the stimulus situation. It seeks to answer the question,

if I have this particular class of outcome performance, how shall I arrange the stimulus situation to bring about its learning most efficiently? And if I have this other, different, class of outcome performance, how shall I arrange a different stimulus situation to bring about its learning in an optimal way? In attempting to answer such questions, of course, a tiny bit of theory, speculation about the information processing, may creep in. For example, it is difficult to avoid the inference that the processing of a concept is probably more complex than that of a discrimination or a chain.

The notable part of this triple distinction, though, is that one begins with classes of performance (learning outcomes) and works backward to establish relations between these different classes and the stimulus situation. As a technique, task analysis does not propose to begin with the stimulus situation, and conduct an analysis which makes possible the inference of various kinds of intellectual processing and then the identification of certain kinds of outcome performances. Note that I do not say that this "forward-going" kind of analysis is impossibl or even undesirable. It may even be the case that task analysis may somehow contribute to it. But task analysis always works backwards from the performance to the stimulus situation.

It may be, therefore, that even at this point in my discussion I can make one clarifying statement relevant to the issues of the symposi This is that task analysis does not have the purpose of analyzing content It may work itself back to content, since that is a way of describing the stimulus situation. But it begins analysis with human performance.

Perhaps I need to mention one more implication of this distinction The classes of performance outcomes conceived of by task analysis may als

be looked upon as inferred potentials for performance which become characteristics of the learner. It is convenient and useful for communication purposes to look upon them in this way. The word I have used to describe these potentials is capabilities. Using task analysis, one says "this class of performance is called concept-using behavior; or this class is rule-using behavior." What then, is the "concept," and what is the "rule"? My answer has been, the concept or the rule is what the individual has learned as a capability. The concept and the rule are stored in the learner's nervous system. By no means are they "out there" in his environment. They are not part of the stimulus.

Further Developments in Task Analysis

These distinctions I have mentioned have been characteristic of task analysis from its inception as a technique designed to yield information about optimal conditions of learning. There have also been some elaborations, refinements, and additions to the procedure. I need to mention two of these before proceeding to comment on "content analysis."

Learning hierarchies. One elaboration of task analysis is the learning hierarchy (Gagné, 1970, 1973 ; Glaser and Resnick, 1972). The learning hierarchy results from an analysis of some target learning outcome, such as "solving simultaneous algebraic equations" or "composing sentences with dependent clauses." It identifies the prerequisite skills for this target task, and then proceeds to analyze and identify the prerequisite skills for those prerequisite skills. I have inadequate time here to give instances of the horrible distortions of this idea that can be found in nationally published and locally

published works.

For purposes of the present discussion, it seems desirable to emphasize the following point. In identifying prerequisite skills, learning hierarchies concern themselves with the internal conditions of learning (Gagné, 1970). That is to say, for the learning of any particular task depicted in a hierarchy, the prerequisite skills must be immediately accessible in memory. Thus, the learning hierarchy is intended to describe only one component of any given act of learning: the essential "content" of memory. Accordingly, it can be said that learning hierarchies do not identify the external conditions of learning. In and of themselves, learning hierarchies tell us nothing about the content of the instructional situation. It is true, of course, that they imply the need for "jogging the learner's memory" about what he has previously learned. But otherwise they are essentially neutral about how the instructional situation--the stimulus situation for learning--should be arranged.

Domains of learning outcomes. A major addition to the procedure of task analysis comes about when one recognizes a larger set of categories of learning outcomes. The single category of intellectual skills was the focus of task analysis in the mid-sixties, and, indeed, is the primary concern of my book The Conditions of Learning (Gagné, 1970). However, one must come to grips with the need for comprehensiveness in describing the outcomes of education or training. Students learn things other than how to perform intellectual operations symbolically. They learn facts, and dispositions to choose courses of action, and complex motor coordinations, and increasingly skillful ways of learn-

ing and solving problems. Accordingly, one of my suggestions has been that we need to recognize five major categories of learning outcome--besides intellectual skills, verbalizable information, attitudes motor skills, and cognitive strategies (Gagné, 1972). Of course, I do not maintain that these categories are entirely novel, since they may be found, with slightly different nomenclature, in the works of others (cf. Bloom, Hastings, and Madaus, 1971; Bruner, 1971).

For task analysis, the significance of introducing these five major categories may be summarized in the following points:

1. The initial categorization of learning outcomes should be in terms of these categories, since they represent distinct classes of human performance.

2. Subordinate categories of each class may be important to identify. This continues to be true of intellectual skills (rules, concepts, discriminations, etc.). The intriguing question is raised, then, of what may be the distinguishable subordinate categories of the other domains--motor skills, or attitudes, or cognitive strategies, for example. The criteria of subordinate categories remains the same: do they require different conditions for optimizing learning?

It should be noted, however, that the introduction of these five major categories of learning outcome does not change the purpose of task analysis in any fundamental way. The technique retains the aim of analyzing any learnable human performance to identify those conditions that contribute to its effective learning. The orientation, in other words, remains toward the learning outcome as the entity to be analyzed. The class of outcome performance is what is identified

by the categories intellectual skill, information, attitude, motor skills, and cognitive strategy, plus the immediate inference that may be made in viewing these classes as human capabilities.

One of these distinctions seems of particular cogency to the topic of this symposium--that is, the distinction between verbal information and intellectual skill. There may even be some question as to whether this distinction can or should be made. The rationale I would present for making it includes the following points:

1. Epistemologists, the philosophers of "knowing," have long found it necessary to distinguish between "knowing that" and "knowing how" (Rozeboom, 1972). The first of these is information, the second, skill, usually intellectual skill.

2. From the standpoint of learning outcomes, it is evident that students acquire a great deal of knowledge, that is, information that they are able to state, or to "tell about." "Telling about" a sonnet is by no means the same as "composing" a sonnet. "Telling about" Newton's second law of motion is not the same as finding the mass of an object when one is given its acceleration and the force applied to it. This is not to deny that, once having learned information, students are able to think about it or with it. But as an outcome, we know that information has been learned because it can be stated, or told. In contrast, we know that an intellectual skill has been learned when it can be demonstrated in terms of an instance of the class of relations to which it refers.

3. The basic reason for the distinction between intellectual skill and information is fundamental to task analysis. If the student is to learn something he must later state--information--the optimal

conditions of learning appear to be different from those which apply to something he is later to demonstrate--an intellectual skill. Evidence from a variety of sources suggests that information is best learned and retained when it can be embedded within a "larger meaningful context." The learning of a new intellectual skill, in contrast, does not appear to require such a context. Instead, the critical condition for learning an intellectual skill, according to much evidence, is the accessibility of prerequisite skills.

4. Finally, it is possible (although by no means established by evidence at this time) that the dynamic features of memory for information are different from those of intellectual skills. For example, the cue of the first sentence of Lincoln's Gettysburg address "Fourscore and seven years ago...." may be quite ineffective in stimulating the recall of what Lincoln said in the rest of the address (I do not mean in a verbatim sense). In contrast, the cue provided by the formula C = 5/9 (F-32) is likely to be completely sufficient to restore the skill of "converting Fahrenheit temperature to Centigrade." Do such examples imply very different characteristics for the retention of information and the retention of intellectual skills?

Task Analysis and Content Analysis

Perhaps it is now appropriate to address the main topic of this symposium. Can task analysis contribute in any ways to content analysis? I suggest that the answer is yes, and in two primary ways.

First, although it was not originally proposed for this purpose, task analysis can be employed to identify the intended outcomes of existin

content. (Remember that I use "content" to mean the stimulus situation for learning). It is possible, for example, to take an existing lesson, say in junior-high science, and to identify the probably intended learning outcomes of every sentence, paragraph, or picture in the text. One may readily find sentences such as "Lenses are used to bend the rays of light," which is information. Other sentences, such as "When passing through a glass lens, the light rays are bent toward the thicker part of the glass" are statements which evidently represent rules (that is, intellectual skills) to be learned. Still others, such as "The optician must know thoroughly the laws of light refraction" may be seen as having the intention of affecting attitudes.

The analysis of existing content, using a task analysis method, may have a number of useful purposes. Chief among these may well be the clarification of what any given lesson is "all about." Many of us have had the experiences of being able to inform a teacher that the type of learning outcome which seems to be intended by a text is very different from the learning outcome desired by the teacher. Thus, a task analysis of an existing text, film, or other instructional package may reveal some exceedingly important information for those concerned with selection of instructional materials.

The second question is, can task analysis be used to analyze what content should be, in other words, to predetermine the characteristics of content for purposes of design? By all means, yes, the technique of task analysis can contribute to this purpose. What task analysis says about this question is the following. In designing a lesson, one must begin by answering the question, what are the lesson's objectives? The

next step is to ask, what class or classes of learning outcomes do these objectives represent (Gagné and Briggs, 1974)? That is, the objectives are categorized into the major classes of information, intellectual skill, cognitive strategy, motor skill, attitude. Intellectual skills, when they are to be planned, are further broken down into the subcategories of rules, concepts, discriminations, and so on. The process of analysis may continue, if necessary, in order to identify the so-called "enabling" objectives for the target objectives of the lesson, and these too are classified into domains of learning outcomes.

Once the outcome classes are known, they can be matched with the optimal conditions of learning for each. In other words, the requirements for instruction, insofar as they are known, can now be specified. In this way the purpose of task analysis is fulfilled.

It is apparent that what gets specified as a result of such an analysis is a stimulus situation that (at least for learners other than young children) usually contains many verbal statements. There may also be pictures and diagrams. Such a corpus may, if one wishes, be called "content."

Some portion of the instructional situation (the "content") is likely to be composed of verbal statements having a mathemagenic purpose, as Merrill and Boutwell (1973) point out. Thus, there may be statements that direct the learner's attention, or stimulate his recall, or provide prompts and cues. Such statements are not themselves a part of what is to be learned--they are used to guide the learner's behavior. Other verbal statements are included in the instructional situation

because they are to be learned; that is, one expects the learner to be able to state them as propositions.

Consider the following sentence as part of the instructional content of a lesson: "A tangent is a straight line which meets a curved line at a point, but does not cross it." Why would such a statement be included as part of instruction? There are two possible and different reasons, and one has to identify the learning outcome before deciding between them. First, the intended outcome may be information. If that is so, then this statement is genuinely a part of the "content," because one expects the learner to state it, or perhaps to answer such a question as, "What two characteristics does a straight line have to have, in order to be a tangent?"

A second and different reason for the inclusion of such a statement occurs when an intellectual skill (a concept) is the intended outcome. In that case, one does not expect the learner to acquire the proposition. Instead, one expects the learner to demonstrate what a tangent is, which he can do by drawing or by selecting examples which are shown to him. For the learning of a concept, the verbal statement has only a mathemagenic function. It would not be included if one were dealing with young children. It works with older children and adults only because they already know the meaning of its component concepts. The statement serves as a cue to the recall of these concepts, and to the ordering of behavior necessary for learning. But, in performing these mathemagenic functions, the statement itself is not something to be learned. Although a part of instruction, it is not "content to be learned."

Concluding Remarks

In summary: Task analysis is a procedure having the purpose of identifying different kinds of performances which are outcomes of learning, in order to make possible the specification of optimal instructional conditions for each kind of outcome. The procedure has been refined, elaborated, and added to since the original work of Robert Miller and others in the mid-fifties. However, it has remained a method of "working backwards" from intended learning outcomes to the instructional situation.

Task analysis may be related to "content analysis" in two different ways: (1) it may be used to identify the probably intended outcomes of existing content (such as a text chapter); and (2) it may be employed to design effective instruction, and thus to determine instructional content. When used for the latter purpose, the distinction is important between content which has a purely mathemagenic function, and content which is itself to be learned. When the intended outcome is an intellectual skill (such as a rule), verbal propositions provide cues for retrieval and other learning processes. In contrast, when the intended outcome is information, verbal statements must be learned as propositions, so that they can later be recalled and stated by the learner.

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